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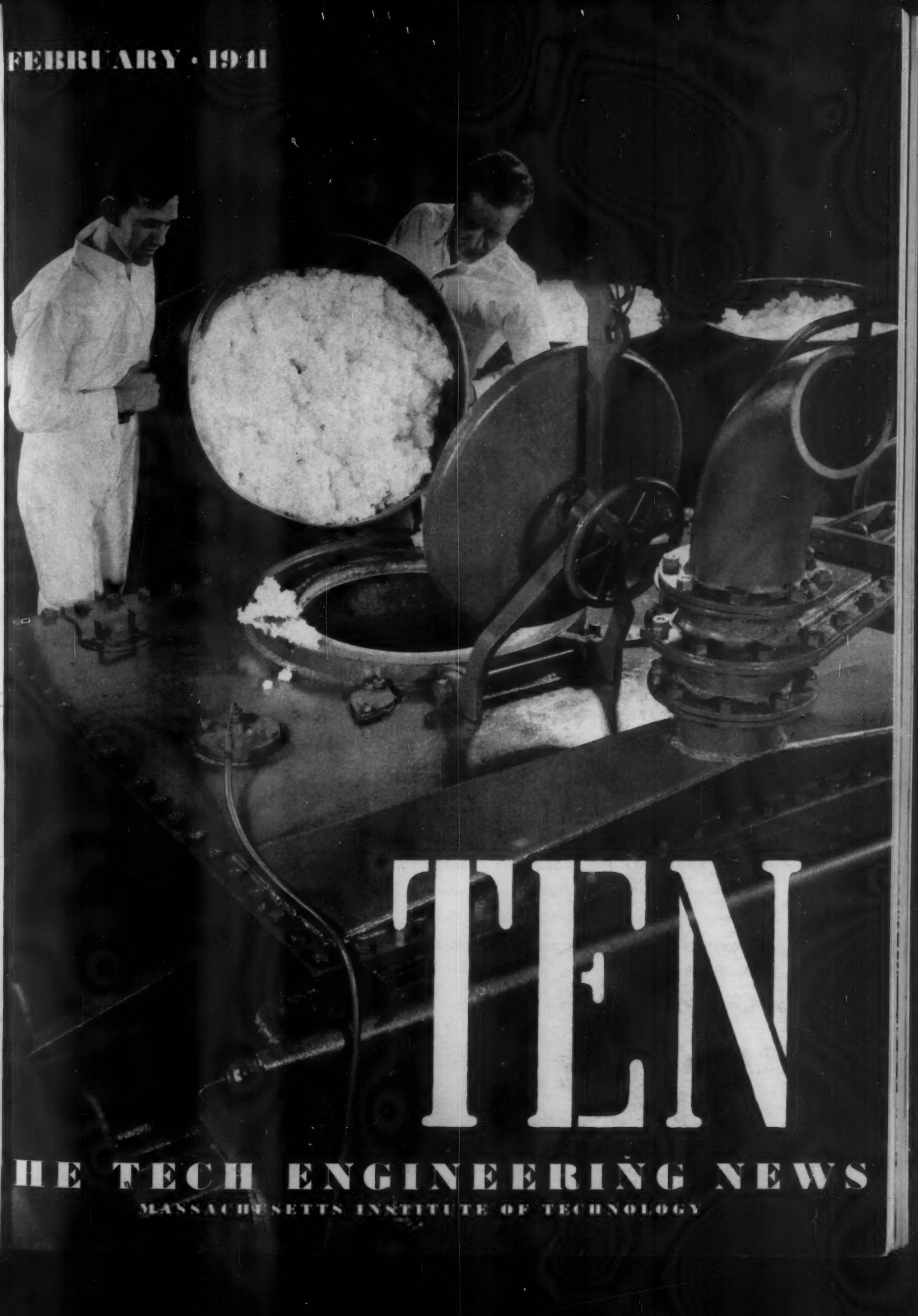

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THE TECH ENGINEERING NEWS

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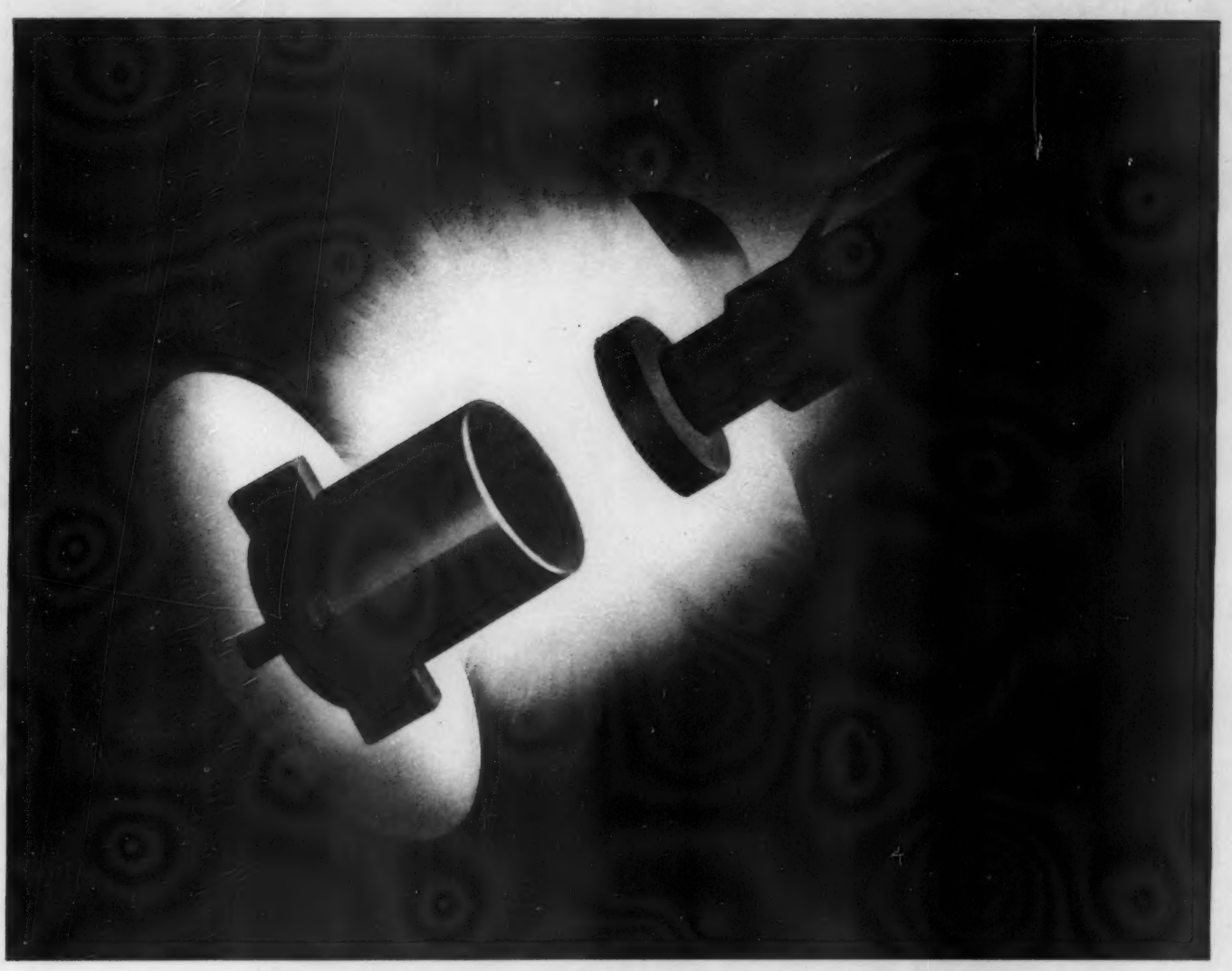

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OUR COVER THIS MONTH
Into the acetylating mixer go cotton linters, acids, and catalysts. (See page 3.)

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NUMBER 1

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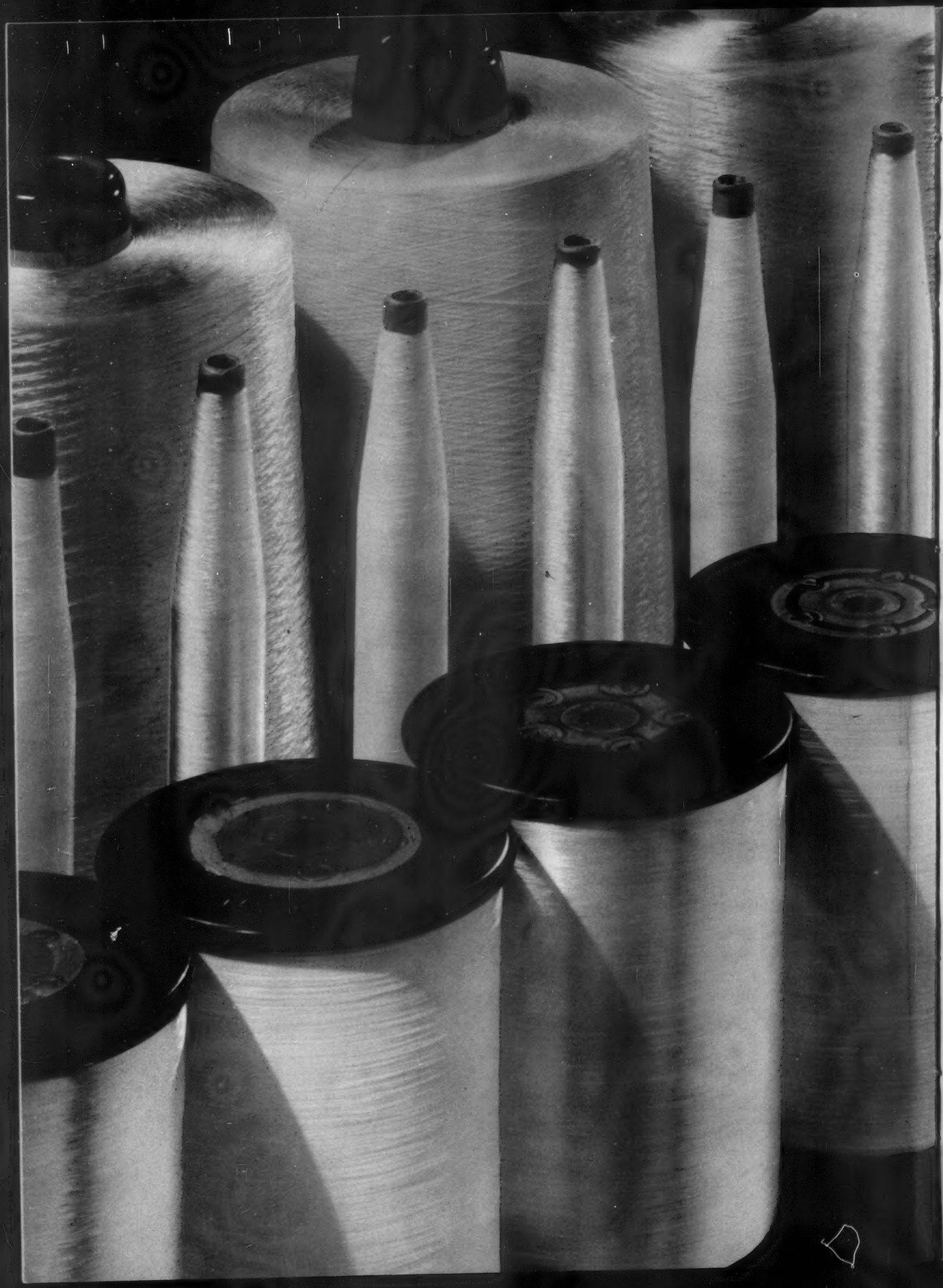


MANUFACTURING ACETATE RAYON

IN THIS INDUSTRY YOU MUST BE CAREFUL OF THE YARNS YOU SPIN

By HAROLD DeWITT SMITH

TEXTILE TECHNOLOGIST, THE A. M. TENNEY ASSOCIATES, INC.

AT the base of the two-story spinning machines in a cellulose acetate rayon plant, a tiny strand glides from each cabinet so smoothly that its swift motion is scarcely discernible. Up and down the rows of spindles, each of which receives the product of one spinneret, the gossamer strands wind onto tall bobbins, filling them at an almost imperceptible rate. One's first impression is that this "mountain" of machinery is laboring to bring forth much less than the proverbial "mouse."

Yet, from this room and others like it in all the acetate rayon plants of the United States, there emerged daily during the year, 1940, some 180 tons of continuous filament cellulose acetate rayon. If this daily production of acetate rayon fibres was laid end to end to form one long fibre, its average diameter would be approximately 18 microns (.0007 inch) and its length some 300,000,000 miles. Actually, a variety of fibres is produced in diameters ranging from 13 microns (as fine as silk) to 45 microns (somewhat finer than human hair). They stream from multiple holes in each spinneret to make strands composed of 12 to 200 continuous fibres for use in silk-like fabrics or, of an even greater number, to be cut into short fibres for cotton- or wool-type fabrics.

The technology of cellulose acetate rayon manufacture has been described too often in both popular and scientific terms to warrant repeating in detail here. Purified cotton linters are reacted with acetic anhydride to form primary cellulose acetate. This is hydrolyzed to produce an acetone-soluble variety with the desired specific properties. This secondary cellulose acetate is precipitated in flake form, washed, dried, redissolved in acetone, and converted into fine, continuous strands of cellulose acetate by extruding at high speeds under tension into warm air. The multifibre strands are then either twisted and wound onto shipping packages or cut and baled as staple fibre.

There are few modern industrial miracles as astounding as the ceaseless streaming forth from huge machines of these fine strands of cellulose acetate fibres, and few industries in which so many branches of scientific and engineering knowledge are integrated and focussed on a problem of such exacting precision and such relentless continuity.

Plant Design

For construction and maintenance of the physical plant, the civil, mechanical, electrical, and chemical engineer are all essential. As in the case of all industrial construction work, the planning of grounds and buildings for maximum efficiency, the construction of buildings, the design of power plant for generating steam and electrical energy, and the provision of an adequate water supply of suitable purity are primary considerations.

The design of reaction vessels, tanks, dryers, solvent recovery systems, stills, refrigeration machinery, air conditioning equipment, mixers, colloid mills, filters, spinning machines, twisters, winding machines, cutters, and inspection and packing equipment requires the complete coördination of the different branches of engineering, each contributing not merely the general knowledge of its own field, but the specialized knowledge of this particular aspect of technology.

For example, the presence of minute amounts of metal salts will affect the color and quality of the rayon and even its subsequent aging qualities and absorption of dyes. Therefore, the metal or other material used in machines, pipes, and valves at each step of the process from cotton linters to shipping cases must be selected to avoid contamination of the cellulose acetate.

Again, knowledge of oils and emulsifying agents used to compound the lubricant or finish which is applied in small amount to the fibres must be so thorough as to insure the selection of materials whose absorption will not affect the fibres during subsequent storage nor react with metals and other materials with which they will come in contact in spinning or weaving or knitting mills.

As a third example, one of the most important raw materials is the water which is used in large quantities for solution and washing during the chemical operations involved in the manufacture of cellulose acetate. The

At the starting line . . . snowy cotton linters

Eastman Kodak

Eastman Kodak

Drastic transformation.
Cotton linters to cellulose acetate in the acetylator.

design of water purification equipment and the maintenance of a supply of water of zero hardness, zero color, and zero iron content through flood and drought call for the best skill of the mechanical engineer and chemist.

Hydraulic engineering enters not only into the design of pumps and pipes for handling water, acid, acetone, and other liquid chemicals throughout the plant; it is required also in designing the equipment for dissolving, blending, filtering, and forcing the very viscous spinning solution, or "dope," as it is commonly called, through the spinnerets. In fact, one of the most important hydraulic problems is on a "micro" scale, namely, to design the spinning-head and spinneret so as to utilize the principles of hydraulic flow to produce the most desirable internal and external fibre structure.

The air conditioning equipment also involves hydraulics with air as the fluid and with accurate maintenance of temperature and moisture content as well as of adequate ventilation in large open areas. Within the confined spaces of the spinning cabinet, accurately conditioned air must also be supplied at carefully controlled velocities and with the minimum turbulence of flow within the shaft of the spinning cabinet.

As the acetone-laden air leaves the spinning cabinet, it leaves the province of the hydraulic and air conditioning engineer and enters the chemical engineer's bailiwick, for a continuous means must be provided, by refrigeration or absorption followed by distillation, to separate the acetone vapor from the air and recover it in pure form for return to the beginning of its cycle in the "dope" mixing department.

Economy demands the utmost utilization of heat not only through efficient operation of boiler room and insulation of pipe lines and vessels, but by the installation of heat interchangers or preheaters wherever a warm liquid or vapor leaves a process and can be persuaded to give up some of its heat to another liquid or vapor whose temperature must be raised on its way to work.

Plant Operation

The operation of the plant and the constant control of quality at every step of production calls for experts in almost every department of chemistry.

The analyst is responsible for the characteristics of every bale of cotton linters and every lot of chemicals which enter the plant or which return to its starting point from a cycle of operation such as the acetic anhydride, for instance, undergoes.

Although the entire process of cellulose acetate manufacture involves organic chemistry, the hand of the physical chemist is on the controls at almost every point. Reaction rates, chemical equilibria, control of degradation of large molecules, azeotropic distillation, diffusion of liquids through solids and of gases through thin, plastic films, control of hydrolysis — all these play a part in transforming the prosaic raw materials into the lustrous fibres. Unceasing vigilance at every stage by means of chemical analyses, and measurements of acidity, viscosity, turbidity, and other physicochemical characteristics is required to produce those tons of tiny fibres in such endless streams. Exacting control of the final product is maintained by physical tests, such as strength, elongation, filament count, filament shape, size, lustre, whiteness, moisture and oil content, density of wind, and final inspection of every skein, spool, or cone before packing.

Process and Product Research

Apart from this daily and hourly routine of plant maintenance and production control, is the work of developing processes to higher efficiency and products to greater usefulness. The operating personnel, the research staff, and the sales service staff must integrate their efforts in this field because in rayon, as in other modern industrial products, the pace of development is rapid and he who stands still is soon left far behind.

The experimental fibre of today is the commercial fibre of tomorrow. The utilization of existing rayons in existing textile mills is constantly revealing possible improvements in textile machinery and in the fibres themselves by which they can be made more suitable for specific purposes. Because the physical characteristics of textile fibres are of primary importance in determining their utility, while the chemical characteristics are on the whole secondary, textile technology is rapidly approaching the point where the application

(*Continued on page 22*)

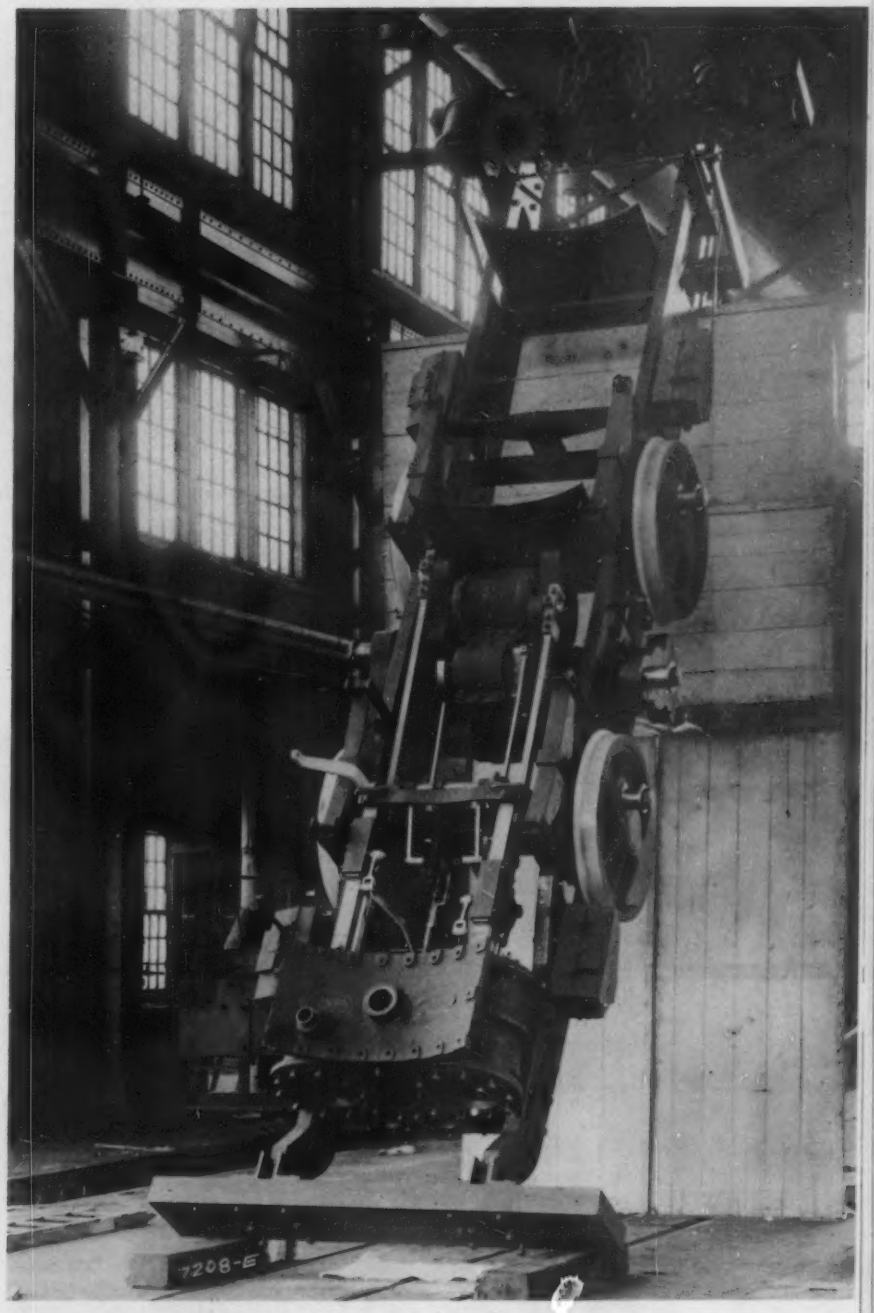
THERMOS BOTTLES ON WHEELS

FIRELESS STEAM LOCOMOTIVES HAVE MANY ADVANTAGES AS SWITCHING AND YARD ENGINES IN INDUSTRIAL PLANTS

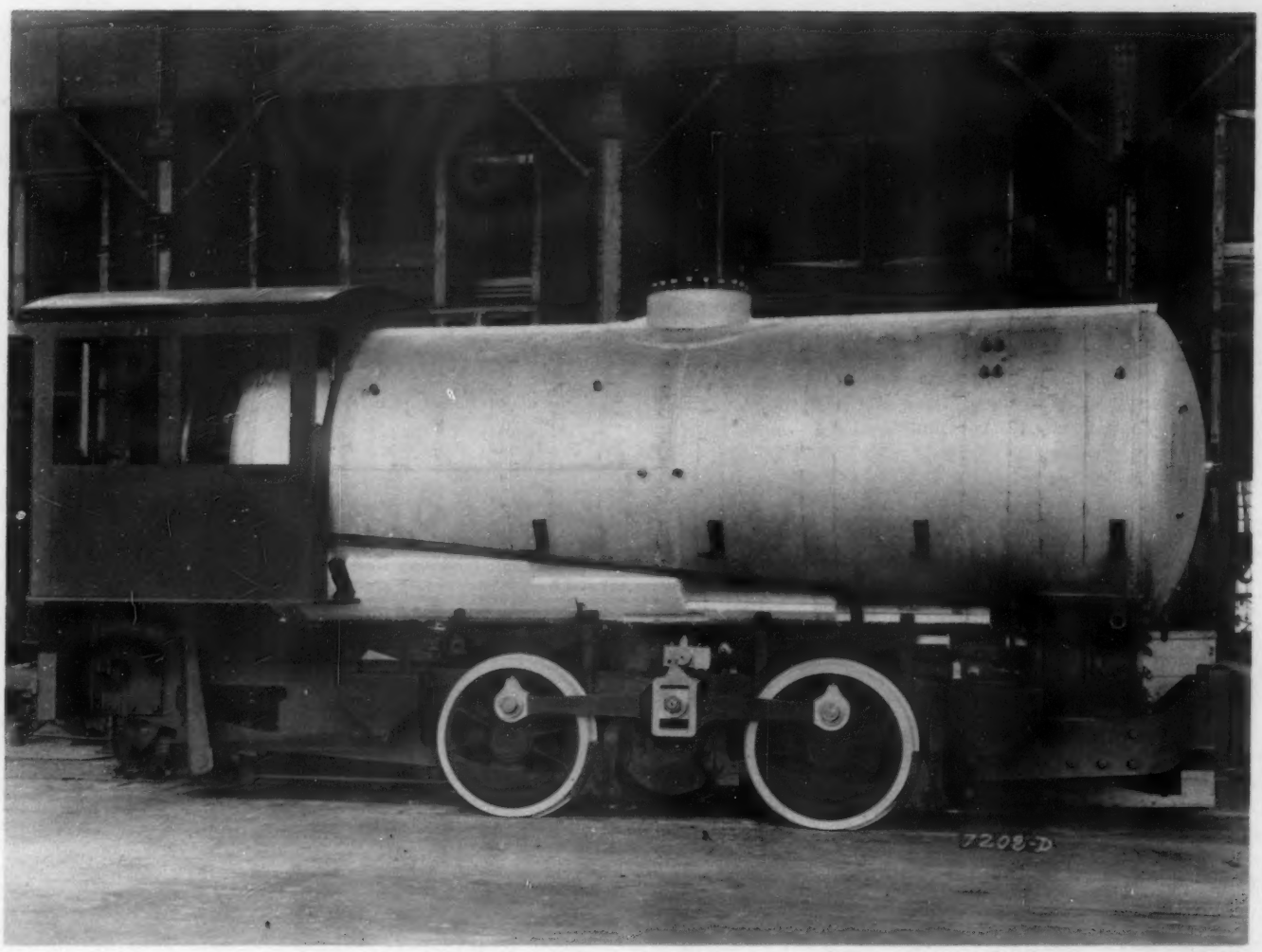
By COMMANDER W. MACK ANGAS (CEC) USN

TWENTY-FIVE years ago switching and yard locomotives at industrial plants were almost universally steam engines burning coal or oil. Today the fuel burning steam locomotive has many competitors in this field, one being the steam storage, or more properly the heat storage engine popularly known as the fireless locomotive. Because the field of usefulness of the fireless locomotive is limited by the distance it can run on a single charge, it can not compete with fuel burning engines of the steam and internal combustion type in services involving operation over considerable mileage of track, but its capability in this respect is usually underrated by those unfamiliar with the effectiveness of the steam accumulator as a device for the storage of power, and the fireless locomotive is undoubtedly dismissed as impractical for service in many industrial plants which it could serve admirably as a switching engine. In plants where stationary boilers operating at a reasonably high pressure are available as a source of steam, and where the mileage of track to be served is not too great, this type of switching engine can often be used advantageously. The fireless engine is safe, it is reliable and it is economical; its economy resting on three undeniably stable supports: low first cost, low maintenance cost and low operating cost.

The fireless locomotive consists essentially of a steam locomotive having a large insulated pressure storage tank instead of a boiler, the tank being charged with steam from a stationary boiler plant. When fully charged the steam supply line is disconnected and the locomotive runs on steam drawn from the tank, returning to the charging station for more steam when the pressure drops to a point indicating the necessity of recharging. If charging such engines meant simply filling the otherwise empty tank with steam at some such pressure as 150, 200 or even 400 pounds per square inch their operating range would be impractically small. It is made surprisingly large, however, by filling the tank about two-thirds or three-fourths full of water before the charging commences and introducing the steam at the bottom through a perforated pipe, the steam condensing and heating the water, which finally reaches a temperature corresponding to that of saturated steam at the charging pressure. The tank when fully charged is from four-fifths to nine-tenths full of hot water, the space over the water being occupied by steam. The



Chassis of geared fireless locomotive



H. K. Porter Co.

Geared fireless locomotive with tank insulation partially installed. Like most modern fireless locomotives this engine has a welded pressure tank

amount of energy available in the stored steam is, however, negligible when compared to the much greater amount available in the form of heat in the hot water. The cylinders of a fireless locomotive are larger than those of an ordinary steam switching engine and valve gear is provided which enables variation of the point of cut-off and consequent effective operation of the engine over a range of steam pressures down to 25 pounds per square inch or even lower. As the engine runs, drawing steam from the top of the tank, the pressure falls and the water boils, forming more steam, the heat energy from the transformation of water to steam being obtained from the hot water remaining in the tank. The operator from time to time notes the pressure in the tank as the engine works and returns to the charging station for more steam when the pressure gauge indicates that the "fuel supply" is running low.

The distances over which a fireless locomotive can operate depend of course upon the size of the machine, the charging pressure, and the loads to be hauled. Perhaps a general idea of the capabilities of such machines can best be given by citing a typical example before taking up theoretical considerations. Two 50-ton fireless yard engines are now serving a shipbuilding establishment which has about 10½ miles of track within its boundaries, the two most remote points to which the engines regularly haul heavy loads being 8/10 and 1½ miles from the industrial center near which the power house and charging station are situated. These engines are now being charged with steam at 160 pounds gauge pressure and require two full charges and two partial charges in an eight hour day of heavy switching. The full charges are obtained before the commencement of work in the morning and during the noon hour, the partial charges being secured at mid-morning and mid-afternoon when circumstances bring the engines to the vicinity of the power plant. Full charges are obtained in 20 or 30 minutes and partial charges in about 10. In anticipation of an increase in the boiler pressure of the power plant of this shipyard the engines were designed and built for operation at 400 pounds pressure and have been given a few experimental charges at this pressure from a test boiler. With such charges they will do heavy switching for well over four hours. One such high pressure trial run started at 8:00 a.m. with a pressure of 380 pounds gauge in the tank. The engine was used until 1:58 p.m. when it failed to pull a 60-ton load with a steam pressure of 20 pounds. In the meantime it had worked steadily, switching and spotting cars, hauling loads a total distance of 13 miles and running light for an additional six miles. During the trial, 150 stops and starts not directly connected with switching operations, such as stops at street crossings, were made. The heaviest single job done by the engine during this run was to haul a string of cars weighing 600 tons three-quarters of a mile and the total useful work done amounted to 987.2 ton miles of switching. As will be shown later, this was a poor performance for a modern

fireless locomotive, considering the steam consumed, but it is doubtful that one of the saddle tank coal burning engines formerly used and still kept in reserve at the plant could have done the work without stopping for fuel and water.

Experience with these engines has shown that there is little more risk of their running out of steam and having to be towed to the charging station than there is of a fuel burning locomotive being similarly stranded. Not only does the operator have a pressure gauge before him which shows when the steam supply is running low but the performance of the engine itself will warn an experienced man of the necessity of recharging should he forget to glance occasionally at the gauge. Furthermore, a locomotive in which the pressure has fallen so low that it cannot haul a load can usually run a considerable distance "light" and thus get to the charging station under its own power.

Theoretical analysis of the feasibility of using a fireless locomotive as a yard engine in a given industrial plant must begin with a careful consideration of the work to be done. The maximum loads to be handled, the grades over which these loads must be hauled, the distances to be traversed with and without load and the degree or radius of curvature of the sharpest curves to be negotiated must be determined. With relevant data selected from these the maximum tractive effort, or draw bar pull, required of the locomotive and the weight on the drivers necessary to develop this tractive force may be computed by the methods commonly used in locomotive design.

The minimum pressure at which the locomotive will develop its full designed tractive effort must be assumed. If the engine is to do miscellaneous switching this pressure may be relatively high, say 40 to 50 pounds per square inch, as in such service an engine rarely handles maximum loads and inability to do so toward the end of a "charge" will not seriously hamper the utility of the machine. On the other hand if constant loads are handled in some repetitive operation, the engine must be able to develop its full tractive effort on the minimum pressure on which it will be called to operate. Cylinder dimensions necessary to develop the required tractive effort may then be determined. These dimensions must be considered in conjunction with the total weight of the proposed engine. If the required cylinder size for a direct connected engine is too big to be practical for a locomotive of the weight under consideration, the possibility of using a geared engine should be examined. A number of geared fireless engines have been built and are in successful operation. Their uniform tractive effort commends them for certain kinds of work and their relatively small high speed engines are more efficient than the larger slow speed engines of direct connected locomotives but they are much slower, especially when traveling light, and in miscellaneous switching and car spotting work can not get out to a job as quickly as a direct connected engine.

From the required weight of the engine and the radius of the curves to be negotiated, the number of drivers and the general dimensions of the largest storage tank which the engine can carry may be assumed. With the tank dimensions known the amount of work which the engine can do on a single charge of steam at a given pressure may be intelligently estimated.

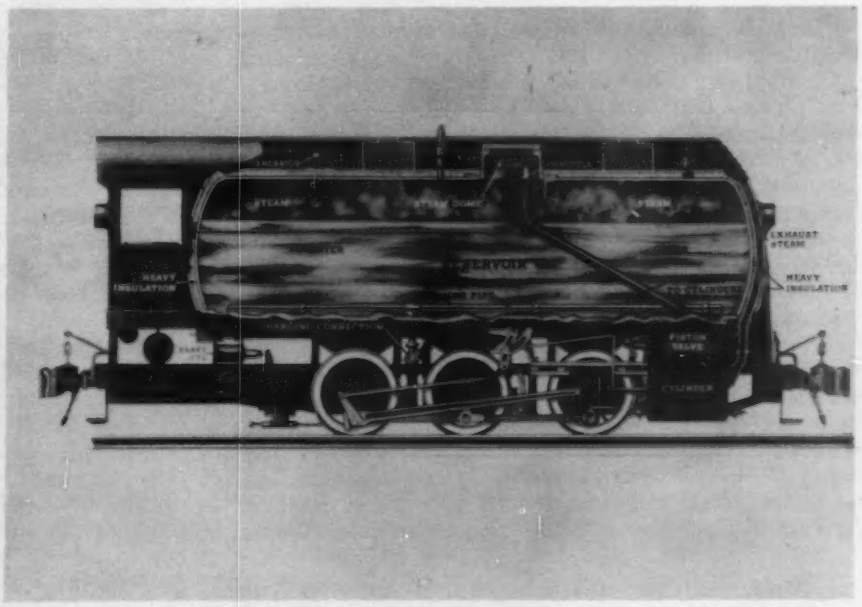
The quantity of steam furnished by an accumulator containing V cubic feet of hot water may be computed by the formula

$$W = \frac{V}{2}(10 \log P_1/P_2 + P_1^{\frac{1}{2}} - P_2^{\frac{1}{2}})$$

where W is the weight of steam furnished, V the number of cubic feet of water in the accumulator (not its total volume) and P_1 and P_2 the initial and final pressures in pounds per square inch absolute. The formula neglects radiation losses which, however, are not large for the few hours a fireless locomotive normally operates on a single charge. Under very favorable conditions fireless locomotives equipped with roller bearings and Walschaert valve gear will consume about 40 pounds of steam per horse power hour of work delivered at the draw bar in switching work, from which an estimate of the ton miles of switching that can be done on a single charge may be made. Another basis of estimate is that under similar favorable circumstances a modern fireless switching engine should do about a ton mile of switching on two and a half pounds of steam but, as will be shown, steam consumption may be more than double this figure.

Using this method of analysis for the trial of the 50-

(*Continued on page 16*)



Diagrammatic cross section of modern fireless steam locomotive. Steam from a stationary boiler plant is introduced through the perforated charging pipe in the bottom of the pressure tank. It condenses and by so doing raises the temperature of the water until finally the approximate temperature and pressure of the stationary boilers are reached. The charging connection is then detached and the locomotive runs on the heat energy stored in the hot water, this energy causing the water to boil and furnishing steam as the pressure drops, until the minimum pressure on which the locomotive will run is reached.

Courtesy H. K. Porter Co.

SEEING TRIPLE AGAIN*

A DESCRIPTION OF VECTOGRAPHS, THE LATEST DEVELOPMENT IN THREE-DIMENSIONAL PHOTOGRAPHY

By PROF. JOHN T. RULE
GRAPHICS DEPARTMENT

AN ordinary black and white photograph might be defined as the image of a scene rendered in terms of various grays, as that scene was projected on the plate of a camera. These grays are produced by particles which absorb more or less of the light which strikes them according to whether the image is to appear a darker or a lighter gray. Such a photograph is an image in terms of quantity of light.

The vectograph is an entirely new kind of photograph with many new possibilities, for it produces a gray scale on an entirely different principle from that of the usual photograph.

In order to understand how this is done it is necessary to review briefly the nature of polarized light.

Though this is a very complex subject an oversimplified explanation will serve our purposes here. Ordinary light is composed of waves vibrating in random planes. Completely polarized light is composed of waves all vibrating in parallel planes. For our purposes a polarizer may be thought of as a transparent material having the capacity to divide every light wave into two components, one parallel to the axis of the polarizer and one perpendicular to it. All the parallel components are transmitted through the polarizer while all the perpendicular components are absorbed by it. Thus all the transmitted light is vibrating in parallel planes. Now if a second polarizer is placed in the beam of transmitted light with its axis parallel to the first polarizer, all the light striking it will be transmitted as there are no perpendicular components. Thus such a second polarizer has no effect whatever on the incident light. If the axis of this second polarizer is perpendicular to the first, however, it will absorb all the light striking it, since this light has no parallel components. Thus two polarizers with their axes perpendicular are opaque.

We have been talking here — and it has been the general practice when considering polarized light — about perfect polarizers. Suppose, however, that we could make a partial polarizer and accurately control the degree of polarization. Such a polarizer would transmit part of the light striking it as ordinary unpolarized light. Half the remaining light would be transmitted as polarized light vibrating parallel to the axis, and the other half would be absorbed. Now consider what would happen if we placed a perfect polarizer in the path of this light. If the axes are parallel, the ordinary light which passed through the first polarizer would now become polarized, while the polarized light would be unaffected. Thus the sum total would be exactly the same as though only one perfect polarizer had been used. If, however, the axis of the second polarizer were perpendicular to the first, a different phenomenon would occur. Half the ordinary light would now be absorbed and half polarized in a plane perpendicular to that of the first polarizer. The polarized light that passed the first polarizer would, however, be completely absorbed. Consequently the light getting through both polarizers would vary inversely with the percentage of light polarized by the first polarizer. Thus if the first polarizer were no polarizer at all, fifty per cent of the light would be transmitted through both. If the first polarizer polarized half the light, twenty-five per cent would get through both; if it polarized all the light, none would get through both. It can be seen that if the degree of polarization were varied over the area of the first polarizer, the percentage of light getting through the second polarizer would also vary and we would have a gray scale. This gray scale might be controlled so as to form a photographic image, but

(*Continued on page 18*)

* "Seeing Triple," John T. Rule, *The Tech Engineering News*, March, 1939.

SCIENTIFIC BREWING

HOW THE BEER YOU DRINK IS MADE

By E. H. VOGEL, JR.
MASTER BREWER

THE production of beer begins with the barley kernel which is taken from the harvest crop and conditioned by a process termed "malting." During this process the meal body is fully ripened, and the enzymes, which act as a catalyst in converting the starch into a type of sugar, are developed. This process is comparable to the ripening and the roasting of green coffee. The highly important enzyme "diastase" developed during the malting process is necessary to effect the conversion referred to above.

Malted barley, commonly referred to as "malt" in the brewing industry, is usually stored in large bins in each brewery, subject to its being "milled" or "ground" as the first step in the production of a beer. Common practice is to grind a predetermined quantity of malt into a cylindrical iron vessel, equipped with a stirring apparatus (electrically driven), which contains a specified amount of water at a temperature determined by the type of "mash" desired. This vessel is called a "mash-tun" and the procedure known as "mashing in." Here the action of the enzyme, "peptase" takes place (a decomposing of the proteins in the malt, regulated by temperature control and according to the formula of the Master Brewer) and later, as will be explained, the enzyme "diastase" becomes active.

The next operation consists of "gelatinizing" the starch of the selected raw grain (rice or corn) by means of boiling same. (The use of a raw material such as rice or corn is common practice in American brewing procedure to accomplish a paler beer, possessing a snappier, less satiating product than that which is the result of an all malt mash.) A predetermined quantity of the raw material (as in the case of the malt) is dumped into a vessel similar to the already mentioned "mash tun," in this instance referred to as a "cooker" because of the necessity of boiling the material with water. After the boiling is complete (indicated by the complete gelatinization of the starch of the grain) the "cooker mash" is dropped or pumped into the "mash-tun" which contains the malt mash. The addition of this boiling mass naturally raises the temperature, which is precalculated to confirm with the "mashing formula," until a "converting" temperature is reached, at which time the enzyme "diastase" of the malt becomes active and converts the starch of the malt and the raw material into a fermentable sugar, of the "maltose" type. After this conversion is complete the entire mash is pumped into another vessel containing a false bottom of perforated or slotted construction and resting about three inches off the bottom of the tank. This vessel is called a "lauter-tun"— lauter meaning to rest. The husks of the barley form a filtering media, immediately on top of the false bottoms, through which the "juice" of the grain mixture called "wort" is permitted to filter. Various types of vessels are used to accomplish the purpose of filtering out the soluble extract, or "wort." (Simple filters are sometimes used, the purpose and results varying to a small degree.) As the liquid filters through the grains it is collected by means of a series of pipes located on the bottom of the tank and draining into a trough which in turn permits the liquid to flow into the "kettle" where it is boiled with hops. (After the grains are washed free of all extract with hot water they are collected and dried and used for cattle feed, commonly called "brewers dried grains.")

The boiling of the wort with hops accomplishes two things, namely:

1. The "wort" is completely sterilized by the boiling process and also relieved of unwanted proteins, which precipitate on boiling.

2. The degree of bitterness is accomplished by the bitter substances of the hops (tannins and bitter resins), thereby developing flavor.

The hops are immediately removed after sufficient extraction by means of a strainer (similar to the removal of coffee grains) and the liquid pumped over a double pipe cooler to reduce the temperature from boiling to about 50° F, at which time the yeast is added, preparatory to fermentation.

After the yeast has been added, the liquid ("wort") is permitted to rest until fermentation sets in, which is usually about twenty-four to thirty-six hours. (The "wort" is now beginning to change from an insipid non-alcoholic and sweet beverage to a palatable fermented beverage); after twenty-four to thirty-six hours the entire brew is dropped into the fermenting casks, which are of pressure type, and the fermentation allowed to continue, being controlled at the desired temperature by means of refrigerated coils. (The yeast splits the sugars of the wort into relatively equal parts of alcohol and carbon-dioxide.) The tanks are equipped with openings on the top, to which is connected a pipe line leading to a compressor which compresses the carbon-dioxide as it is being liberated during fermentation, into carbon-dioxide storage tanks, where the gas is permitted to remain until used later in the process.

After fermentation is complete (seven to twelve days) the beer is pumped into ageing tanks, in which the beer becomes "mellow." When fermentation is complete and the beer removed from the fermenting tank, the yeast crop will be settled on the bottom of

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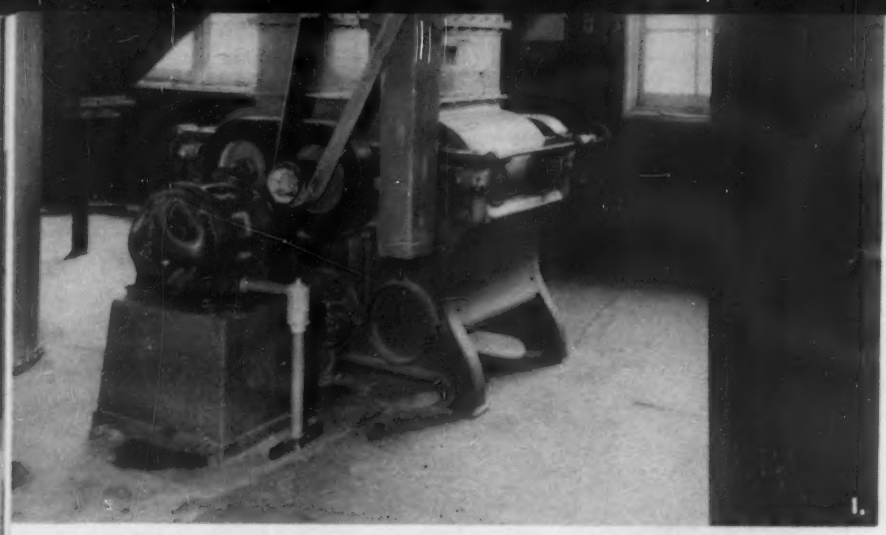

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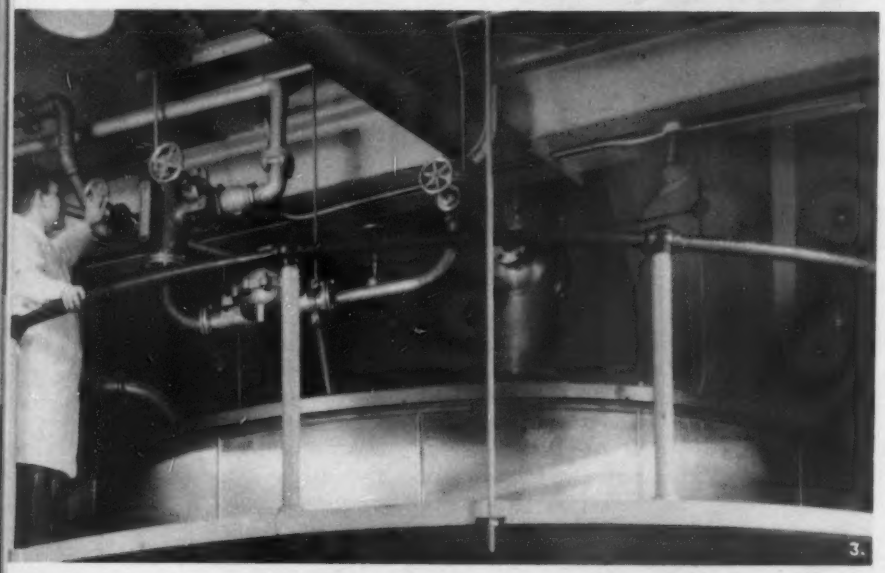

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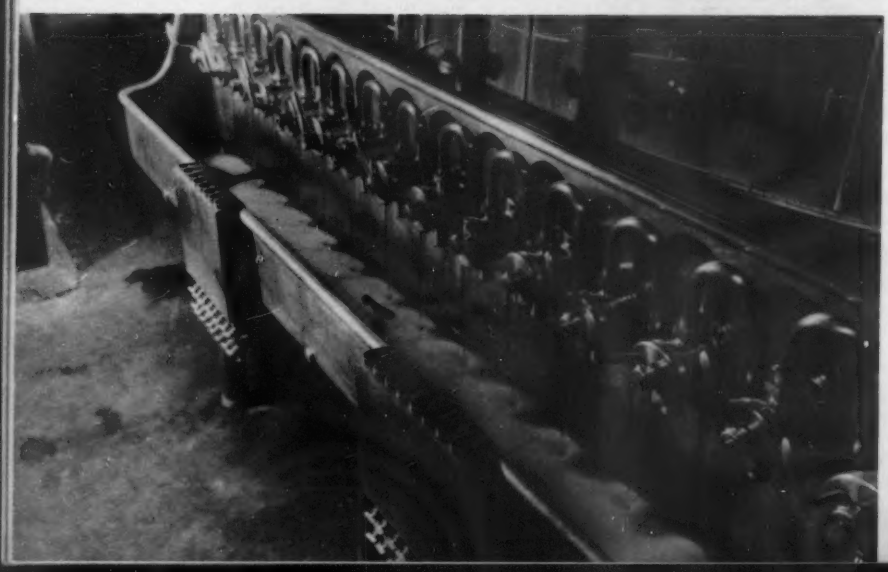


FROM BARLEY TO BEER

1. MALT MILL. Here the beer is started by the grinding of the malted barley.

2. RICE MILL. The unmalted cereal, rice, is next ground, to be "mashed" with malted barley.

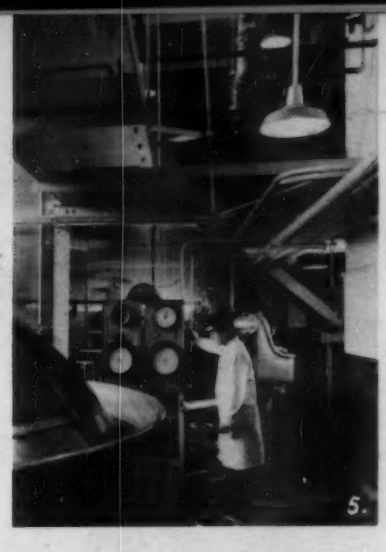
3. MASH-TUN. Here the malt and rice are "mixed" with water at specific temperatures for conversion; after the rice has been boiled or gelatinized.

4. LAUTER-TUN. False bottom draining vessel, using the husks of the malted barley for a filtering bed. The liquid is called "wort" and is draining to the Kettle.

5. BREW KETTLE. Here the "wort" is boiled with hops for flavor. In background is lauter-tun, with operating board.

6. YEAST DEPARTMENT. Yeast is stored in these tanks, collected after each fermentation, approximately doubling itself in weight during fermentation, used over and over again if biologically sound. It is added to the wort immediately after the wort has been cooled.

7. FERMENTING TANKS. Closed fermenting tanks, the sugar of the wort splitting into approximately equal parts of alcohol and carbon-dioxide, the latter compressed into gas storage tanks for later use.

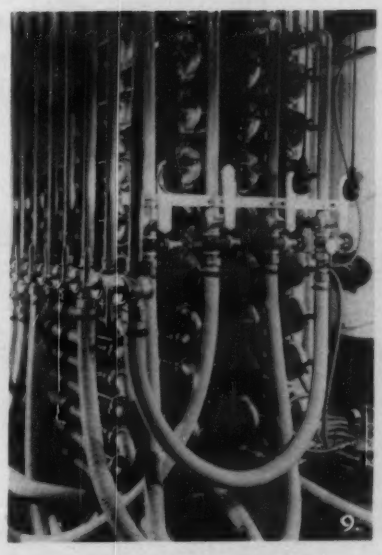


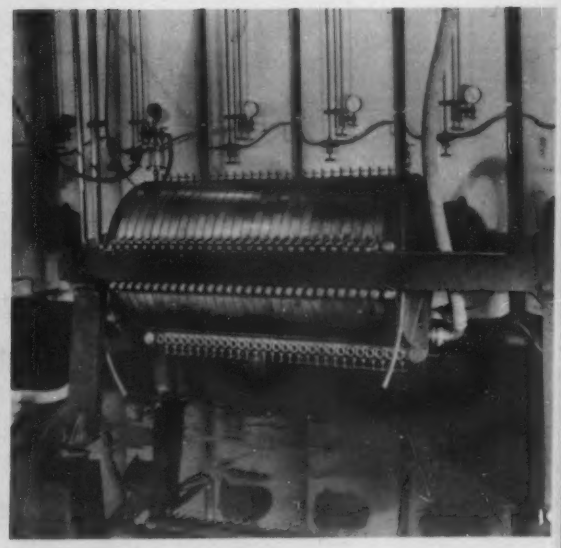
8. AGEING TANKS. Tile-isle, each tank being of glass-enamel construction, with sight glasses, gauges, etc. of stainless steel.

9. COOLERS (Double Pipe). Here the matured beer is cooled to approximately 29° F. for protein stability.

10. DIATOMACEOUS SILICATE FILTER. Used for clarifying beer prior to its final filtration. (Note CO_2 storage tanks referred to in illustration No. 7.)

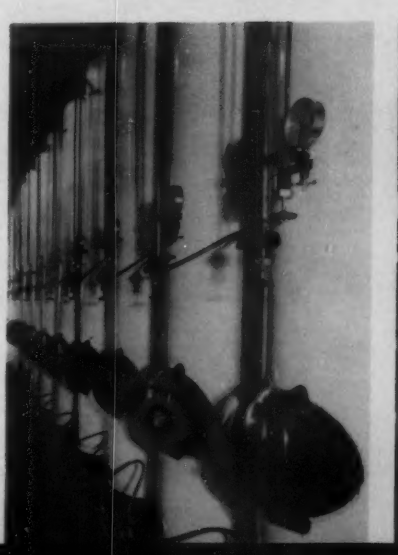
11. CO_2 STORAGE TANKS. The fermentation gas collected is compressed into these tanks, used for pressure on the beer.

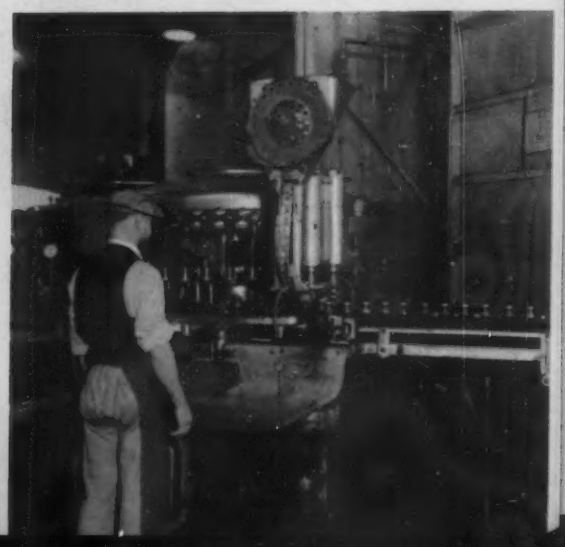




12. FILLER AND CROWNER. Inspection of bottles.

Draught beer is not pasteurized because it is not subjected to the shelf life and various temperatures such as bottle beer. Draught beer is usually packaged in steel or wood containers, both possessing some sort of coating unless stainless steel or aluminum is used. Beer must never in any way be permitted to come in contact with uncoated wood or steel. In the former case it would "take on" the wood flavor and in the latter instance it would be subjected to a metal-haze possibility.





Can a Railroad T

A STATEMENT BY

EDWARD G. BUDD

RAILROAD men can examine a piece of equipment and classify it as either "not safe" or "safe." "Safe" equipment is the rule on American railroads and the public knows it. Passengers no longer question the safety of trains they ride on. They have implicit faith in the judgment and ability of every man connected with railway operation and maintenance.

Why then, many ask, should the Budd Company build trains that so far exceed accepted safety standards? It's a good question!

We believe that there's no set limit to safety. As long as research develops new, stronger materials and new ways to make them into safer trains, man should keep right on bettering his product. If it hadn't been for such progressive spirit, railroad trains wouldn't be so safe today. And Budd thinks the same spirit should lead to greater achievements.

That's why Budd builds the strongest, safest trains that can be built. That's why every car is built through and through of stainless steel, the most expensive and strongest material used structurally today. That's why we fabricate by the exclusive SHOTWELD★ process, invented and developed by Budd.

As long as passengers expect the best from the railroads, Budd intends to build the best . . . regardless of cost . . . regardless of competition. Progressive railroad management has shown by its purchases of Budd equipment that it thinks the same way . . . that no train can be "too safe."

Edward G. Budd

PRESIDENT

EDWARD G. BUDD MANUFACTURING COMPANY, Philadelphia

★Reg. U. S. Pat. Off.

BUDD METHODS SAFELY ELIMINATE DEAD WEIGHT

Train be "TOO SAFE"?

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HASTE MAKES WASTE

There is a lot of loose talk nowadays about the slowness of industry in producing defense goods. Some people cannot understand why, for example, the automobile industry, which uses mass production, assembly-line methods, cannot immediately turn these facilities over to mass production of tanks or airplanes. What such people fail to take into consideration is the fact that it takes a great deal of research, trial and error — a great deal of "make-ready," to quote Charles F. Kettering — before any product of industry can be safely put on a quantity production basis.

When the government suddenly decides it has to have a large number of tanks and airplanes built according to the latest military specifications, the industry that is asked to build them has to start from scratch. For in peace time there is relatively little manufacture of these complex instruments of war. As a result industry must design and build special plants, machines, and tools before it can begin to make these defense items. It must devise new methods of manufacture encompassing the stringent demands of the army and navy. It must discover adequate sources of raw materials and special parts. It must train men for new and more precise skills. Finally it must develop new mass production methods and force the new products through rigid tests. This process of "made-ready" is long, arduous, and nerve-racking. It means many sleepless nights for engineers, manufacturers, and others before the mass production methods can be put on any kind of an operating schedule.

During the process of "make-ready," it often happens that after several weeks or months of work on the original plans, an order is rushed in necessitating a revolutionary change in the previous lay-out. Such changes are of course the result of some research work or other discovery. They naturally must be made because without them the original product becomes obsolete. But such changes unfortunately delay or even junk the original plans. Mass production of the item thus has to be postponed until later.

If you hear somebody criticize industry for its slowness in setting mass production methods into operation, tell him to stop and think about what has to be done to manufacture the complex, precision-made implements of modern warfare. Make him realize what a hodge-podge mess industry would be in if hours, weeks, months, and even years of research and experiment were thrown aside and manufacturers attempted to plunge right into quantity production of an item they had had no experience or practice in making. There is no substitute for "make-ready."

The proces of "make-ready" applies just as thoroughly to peace time as it does to war time. Observe the airplane industry and note the revolutionary and rapid changes made in the past fifteen years. You will see how transport planes have been rendered obsolete (although still useful) before they are put into service, by new models in the process of design and development. This fact explains why transport planes were not yet being built in large numbers up to the time of our national defense emergency. Yet our transport planes are the best in the world.

"SOFT WORDS BUTTER NO PARSNIPS"—*Galsworthy*

Utterances by certain prominent individuals in this country have made us realize that even we Americans are not immune to the moral disease which, so we learn, has reached its zenith in Germany and is spreading through other countries. This disease is a lack of moral indignation toward the atrocities and bestial brutalities committed and condoned by the gangster rulers of the fascist states. We learn that the people of Germany actually pity the lot of the Jews and other political and racial outcasts; but we also learn that the

(*Continued on page 24*)

Developing better apparatus of many kinds at lower cost is a continuous process in the Bell System. It plays a major part in making your telephone service the finest and cheapest in the world. Here is one of many cases in point:

Above you see two telephone loading coils — one old, one new. Such coils are spaced at regular intervals along telephone circuits. They reduce electrical losses... help to bring your voice through clearly, strongly over long distances.

Through the years, engineers at Bell Telephone Laboratories have succeeded in making these coils smaller and smaller. In so doing, they have greatly reduced the cost per coil, which... multiplied by the millions in use in the Bell System's nation-wide network... has helped to keep the cost of out-of-town service low.

Why not telephone home at least once a week? Long Distance rates to most points are lowest any night after 7 P. M. and all day Sunday.

THERMOS BOTTLES ON WHEELS

(*Continued from page 7*)

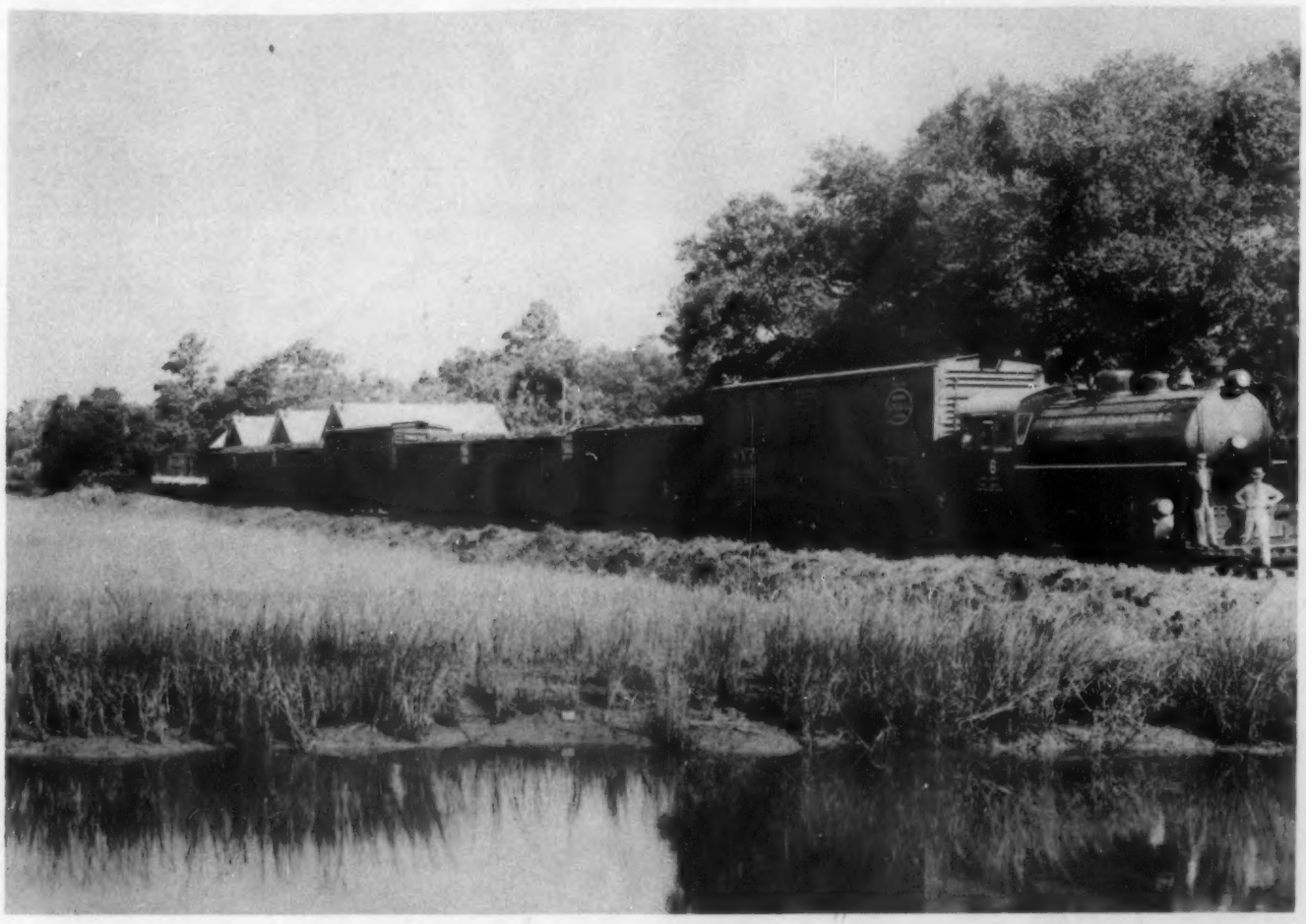
ton fireless engine previously mentioned, it appears that 6,219 pounds of steam were available from the 635 cubic foot storage tank, assuming it to have been 80 per cent filled with water at the commencement of the five hour and 58 minute run. The total ton miles of freight handled is exceedingly low, or putting it another way, the steam consumption per ton mile of switching accomplished was very high, being 6,219 ÷ 987.2 or a little less than 6.3 pounds per ton mile. The poor showing made on this run was no doubt due to four factors: the engine was new and "stiff," it was in the hands of an operator unfamiliar with it, most of the car movements made were very short, and a large amount of steam was wasted in running light and in starting and stopping at street crossings.

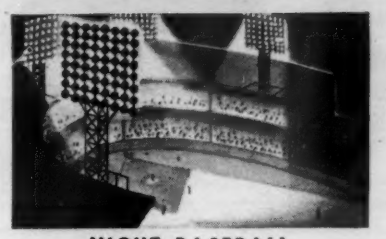
Although the economy of the fireless locomotive is one of its most attractive features, it has other advantages over the fuel burning steam locomotive and many types of internal combustion locomotive. Among these may be mentioned absence of fire hazard, almost complete absence of explosion hazard, a clean exhaust which makes it feasible for the engine to enter buildings in which even the fumes from an internal combustion engine would be objectionable, and quiet operation.

The principal disadvantage of the fireless engine is its inability to make runs of over a few miles or do work other than switching over a limited mileage of track. In the early days of the fireless engine, for it is an old and not a new device, it was used to a considerable extent for hauling street cars and for very short interurban passenger service, but electric traction and internal combustion engine power are far superior for such service today. Another disadvantage is that should an engine run out of steam at a distance from the charging station, a most unlikely mishap, it must be towed in for recharging. Fuel can be sent to a stalled oil or coal burning locomotive but it is impractical to send steam to a stalled fireless. A third disadvantage, the seriousness of which is apparently not generally appreciated, is that the tank of a fireless engine is usually very bulky and the operator's view "forward" is consequently much restricted. This restriction of the operator's vision is so serious as to necessitate carrying a second man on the "fireman's side" of fireless engines in some kinds of switching service, though one man could handle the engine insofar as its operation is concerned. A mirror or periscope device may solve this problem some day and make the fireless switching engine a one man machine under all conditions.

The disadvantages mentioned above are, however, more than offset by the advantages of the fireless steam locomotive as a yard engine for plants which it can effectively serve. Where the work to be done lies within its ability and where steam for charging is available from a boiler plant operated for other purposes, the fireless engine is proving a most satisfactory yard locomotive in many industrial establishments.

Fireless engines can pull heavy loads. This fifty ton engine is pulling a heavy string of loaded freight cars into the Charlestown Navy Yard

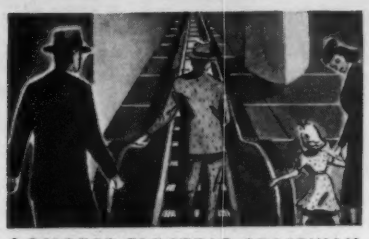




NIGHT BASEBALL

Six major league parks have been equipped by Westinghouse for night baseball. Each of these "8-tower" installations develops approximately the following amount of light:

1. 750,000 Candle power
2. 100,000,000 Candle power
3. 2,575,000 Candle power
4. 210,000,000 Candle power



LONGEST ELECTRIC STAIRWAY

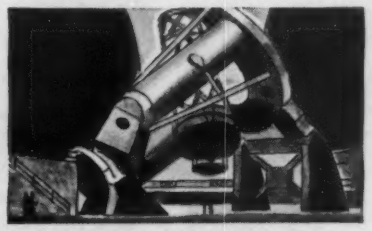
Two years ago Westinghouse engineered and built the longest electric stairway ever used in this country. It was designed to:

1. Save subway riders millions of steps.
2. Transport passengers to the top of the Empire State Building.
3. Carry shoppers from floor to floor in Macy's Department Store.
4. Transport World's Fair visitors to the inside of the Perisphere.

THE STERILAMP

Science has acclaimed the new Sterilamp developed by Westinghouse because:

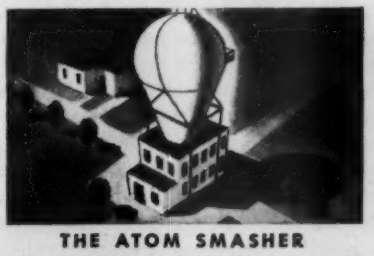
1. It provides normal daylight for classrooms, offices and factories.
2. It facilitates medical diagnosis of difficult pathological conditions.
3. It kills micro-organisms with ultraviolet radiation.
4. It extends the range of airway beacons.



THE LARGEST TELESCOPE

The 200-inch telescope for which Westinghouse designed and built the mounting is now being erected:

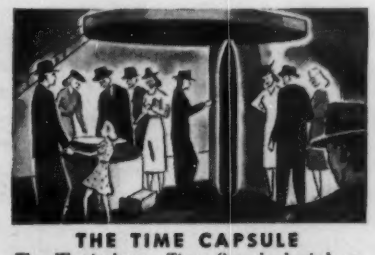
1. On Mt. Palomar, California.
2. On Bear Mountain, New York.
3. On Sankaty Head, Nantucket.
4. On a mountain in Aberdeen-Hoquiam, Washington.



THE ATOM SMASHER

The giant 90-ton atom smasher in the Westinghouse Research Laboratories is used principally for:

1. Testing the tensile strength of metal.
2. Measuring the impact of projectiles.
3. Conducting theoretical research in nuclear physics.
4. Providing high-voltage beam for deep X-raying.



THE TIME CAPSULE

The Westinghouse Time Capsule buried on the site of the New York World's Fair contains:

1. Various plans for universal peace.
2. A record of contemporary civilization.
3. Autographs of celebrities who visited the N. Y. World's Fair.
4. A list of the most important electrical inventions of the twentieth century.

Just a Word Before You Begin

Here's an opportunity to test your knowledge of electricity and measure your familiarity with important developments in the field of science.

Optional answers are provided for each of the six situations illustrated at the left. Your task is to select the one that's correct. So that there'll be no temptation to peek, the answers are printed below, upside down.

If you get four out of six correct your knowledge of electricity is average. Five out of six is good. If you chalk up a perfect score the class ought to vote you "most likely to succeed."

★ ANSWERS ★

Night Baseball ..... Ans. 4.
Longest Electric Stairway ..... Ans. 4.
The Sterilamp ..... Ans. 3.
Largest Telescope ..... Ans. 1.
The Atom Smasher ..... Ans. 3.
The Time Capsule ..... Ans. 2.

Westinghouse "The name that means everything in electricity"

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SEEING TRIPLE AGAIN

(*Continued from page 8*)

this image would exist only if the axis of the second polarizer were perpendicular to that of the first. If it were parallel, uniform light would be transmitted and no image would exist at all. This latter fact is very important.

Our problem then reduces itself to making our first polarizer an image in terms of per cent of polarization, such an image only to be rendered into a completely visible photographic image by a second perfect polarizer with crossed axis. This is done in the following way. A transparent sheet is made of long-chain polymer molecules all oriented parallel to each other. Though these molecules are oriented they are non-polarizing molecules. A wash-off relief is made from the negative of the desired photograph. This relief is dipped into a printing solution. This printing solution has the capacity to react with the molecules of the oriented sheet and to convert them into polarizing molecules. The wash-off relief absorbs varying amounts of solution according to its thickness. Where the photograph is to be black, it absorbs enough to render polarizing all the molecules of the sheet that it contacts. Where it is to be white, it absorbs none at all. Where it is to be gray, it absorbs enough to polarize a percentage of molecules equal to the desired per cent of gray.

The wash-off is then placed in contact with the sheet and the sheet becomes polarizing as desired. This sheet when viewed through a perpendicularly oriented polarizer will appear to be a photographic image of the same character as the ordinary picture. When viewed through a parallel polarizer it seems to be, and actually is, a perfectly transparent sheet.

We may see from this that a vectograph is an image in terms of degree of polarization and is therefore entirely new to photography. It is called a vectograph because it produces an image by controlling the vectorial properties of light.

It will be seen immediately that since we have two eyes, if we put a perpendicularly oriented polarizer before one eye and a parallel oriented one before the other, one eye will see the picture and the other eye will see a transparent sheet.

If now we make our sheet so that the molecules on one side are oriented perpendicular to the molecules on the other, we can have two different pictures, one on each side of the sheet, so that one eye will see one picture and the other eye the other without the slightest interference between the two. If the two pictures are a stereoscopic pair, all the necessary conditions for making a three-dimensional picture have been met.

This is easily achieved by making two wash-off reliefs, one from each of the stereoscopic pair, one being a mirror image, that is, printed through the back of the negative. These reliefs are registered stereoscopically and bound at one end with a piece of tape. After this has been dipped in the ink, the vectographic sheeting is inserted between the two reliefs and the entire sandwich is run through a wash ringer. After a minute or so the wash-off reliefs are removed and the process is complete. The sheeting now becomes a three-dimensional picture when viewed through the proper spectacles.

WHY DO COMPANIES ADVERTISE IN COLLEGE TECHNICAL MAGAZINES?

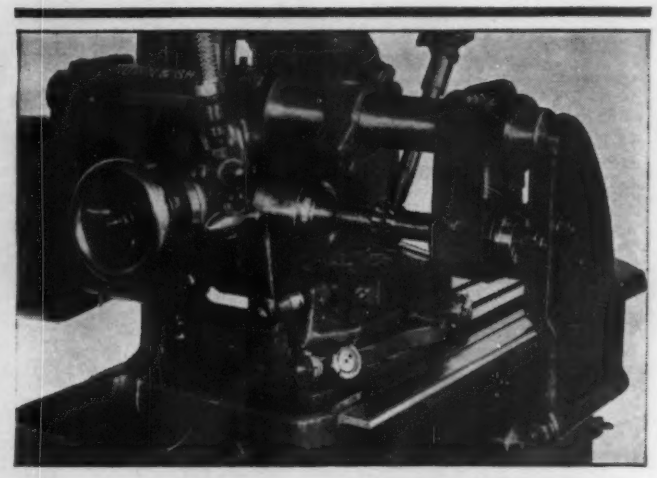
What benefits are derived from soliciting engineering students who as yet have nothing to do with business? The answer is that they are soliciting good will which will pay dividends in the future. You and I are the ones that in the years to come will be dealing with these companies. We are the purchasing agents who will be buying their goods, or we may be selling goods to them; in any event it is then that their present investment in advertising with the college magazines will pay dividends. For through their continued advertising we have a knowledge of their functions, of their personnel, and of the services they perform to the people of the world. All of this background of these companies will not be forgotten by the students who are the important men of tomorrow.

Such three-dimensional pictures have many unique advantages over any other known three-dimensional process. Since they are superimposed all restrictions of size have been removed. The necessity for using a cumbersome stereoscope has been done away with, only a pair of polarizing spectacles being necessary. Thus a number of individuals can view the picture at the same time or can view a number of pictures at once.

Furthermore, since the two pictures occupy the same place at the same time, they can be projected through a single projector onto a non-depolarizing screen and viewed by a large audience. This means that standard lantern slide projectors and standard movie projectors can be used. As one of the great objections to three-dimensional movies has heretofore been the necessity of having a double projector or of using the defective red-green system, such movies are brought very much closer by the vectograph.

The use of vectographs is by no means limited to stereoscopic photography. It is very useful in any situation in which it might be desired to see two pictures in rapid succession. This is done by rotating one polarizer between the eyes and the vectograph, the two pictures being seen in rapid alternation depending on the speed of rotation. This is useful for detecting minute changes in two pictures of the same scene. It also is very effective in showing vibrational effects.

The vectographic process was invented by Mr. Edwin H. Land of the Polaroid Corporation. The sheeting and the ink for making vectographs can be obtained only from them. They also supply the necessary viewing spectacles. I am greatly indebted to Mr. Land for the privilege of describing the process.



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SCIENTIFIC BREWING

(*Continued from page 9*)

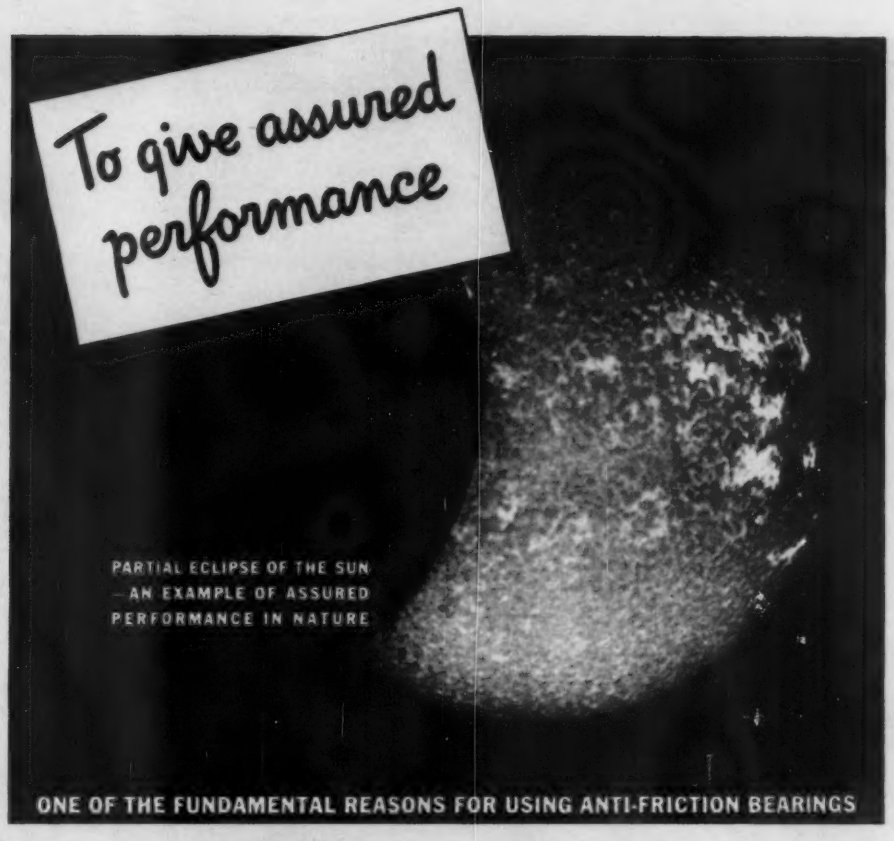
the tank (lager beer) in quantities usually double its original weight, and is used again in the subsequent brews. (In ale beer the yeast rises to the top rather than going to the bottom of the tank after fermentation is complete, due to the nature of the species.)

The ageing of beer causes any remaining yeast, which may be in suspension in the beer, to settle out. Also a "ripening" of the flavor takes place and is determined by taste and aroma. The length of time necessary to accomplish the desired results depends on many items. An "overaged" or too old beer is as undesirable as one which is not fully aged, the ageing process being in no way comparable to that of raw alcohol (whiskey). Beer has many important constituents which compose its flavor. and alcohol is only one of them.

After the ageing (sometimes called "lagering") the beer is filtered into another tank and impregnated with its own gas which was collected during fermentation. This gas causes the foam, the lasting and creamy qualities of which are largely dependent on the method of "carbonation" and the quality of the carbon-dioxide. From here it is refiltered and either put into packages for draught outlets or bottled. In the case of the latter the beer after bottling is "pasteurized" to retard the browth of bacteria and fermentation.

It is interesting to note that Dr. Louis Pasteur, like many other scientists, made a name for himself by his work in a brewing laboratory. Many men today are employed in brewing laboratories working on yeast vitamins and their derivatives. Their work should prove of great value when it is eventually completed.

A typical battery of gigantic aging tanks. *Schlitz*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BECAUSE of the dependence placed upon them in the production line, machines of modern design can afford to employ only those parts whose reliability and service life can be accurately determined *before* they are used. That is why more and more machine builders are standardizing on ball bearings, the fundamental bearing type which gives assured performance.

The ball bearing has a thoroughly sound background of scientific principle governing its design, and the life and capacity of ball bearings—New Departure *ball* bearings—are subject to as accurate mathematical determination as is the strength of a steel bridge. New Departure ball bearings are the last word in anti-friction bearings.

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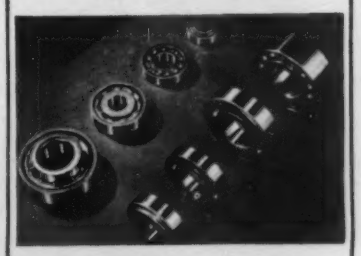
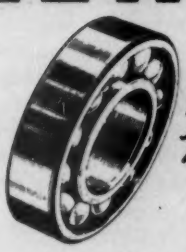


Millions and millions of New Departures of all types and sizes must be right, when uniformly they demonstrate the same result — that their performance in the field is precisely as determined by the bearing engineers, before they made even one revolution in a wheel or on a shaft.

ENGINEERING STUDENTS: For free brochure, "Bearings—the Life of the Machine," write New Departure, Division of General Motors, Bristol, Connecticut.

NEW DEPARTURE

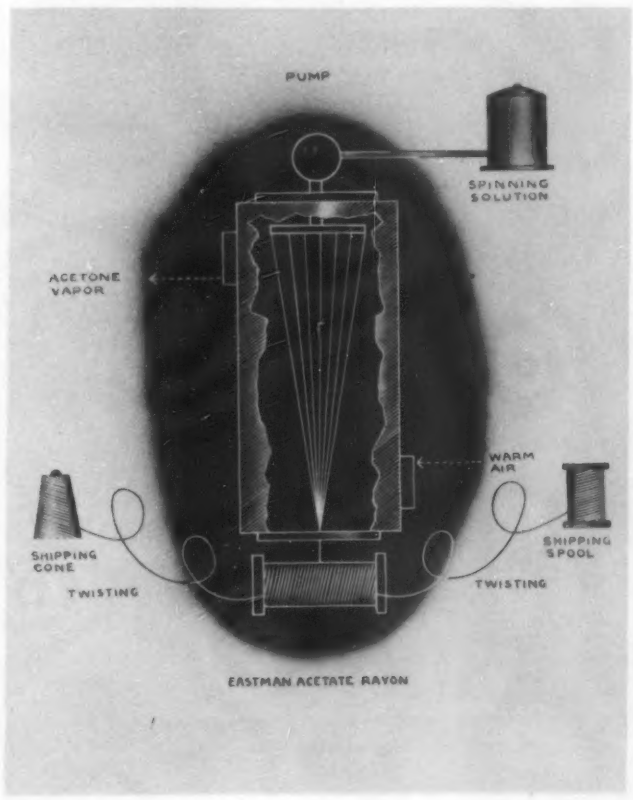


BALL BEARINGS

Nothing Rolls Like a Ball

Not yet ready for spinning, cellulose acetate is hydrolyzed in huge storage jars. Frequent tests insure uniformity in the finished products. *Eastman Kodak*

The manufacture of acetate rayon



MANUFACTURING ACETATE RAYON

(*Continued from page 4*)

of engineering principles and knowledge to the behavior of these tiny "beams" under various stresses, both singly and in the groups which make up yarns and fabrics, will form the scientific foundation on which the textile designer will base his artistic creation of textures and body and "hand" or feel. The study of "fibre mechanics" will rapidly diversify the types of available acetate rayon fibres as well as of the other rayon and synthetic fibres.

Having examined some of the complex skills which are required for producing cellulose acetate rayon, it is natural to inquire what really moves this mountain of machinery, and the industrial army which mans it, to bring forth a cellulose acetate fibre. The driving forces are the whims of woman and the demands of man for textiles to adorn and textiles to serve the manifold aspects of our modern civilization.

Continuous filament acetate rayon entered the field when the force driving the rayon industry was the elemental desire to produce a cheaper but adequate substitute for the luxury fibre, silk. Technological improvement since that time has reoriented textile thinking to the viewpoint already stressed, namely, to the production of diverse fibres for specific, diverse purposes. The introduction and rapid growth of acetate rayon staple fibre have contributed to the diversification and thereby greatly broadened the field of service of cellulose acetate textiles.

In clothing, continuous filament acetate yarns are

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omnipresent in street and evening wear and lingerie for women and in suit linings for men. Shirts, socks, neckties, scarfs, certain types of summer suitings are other articles in which acetate rayon appears. The acetate staple fibres, either alone or blended with other types of fibres, ushered in a new category of sports wear for both men and women because of the crush resistance, the stability to laundering, and the pleasing cross-dye, or two-tone, effects which they impart. Shirts, slacks, shorts, dresses, and ensembles, of soft or crisp nature, flannel-like in feel but light and airy in texture, have taken over the field of dress for sports and for play.

In household textiles, acetate rayon appears in draperies and bedspreads of taffeta and other weaves. Experiments indicate that acetate staple fibre will soon find a place in blankets and in carpets. In industrial fabrics, acetate rayon is used for electrical insulation and in a modified form for the production of a new type of felt. Its military uses are now being explored with a prospect of parachute fabric made from an especially strong type, and of shirts, uniforms, coats, and blankets containing a blend of acetate staple fibre with other fibres, should the restriction of wool imports become acute.

Despite the tremendous production and variety of uses which cellulose acetate rayon has already enjoyed, the versatility of this man-made textile material has not yet been adequately explored. Rayon has greatly accelerated the evolution of textile technology from its traditional status of an art towards its future status as a science and has freed it forever from the limits imposed by the properties of the natural fibres.

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SAMSON CORDAGE WORKS 89 Broad Street, Boston, Mass.

FRANKLY SPEAKING . . .

(*Continued from page 14*)

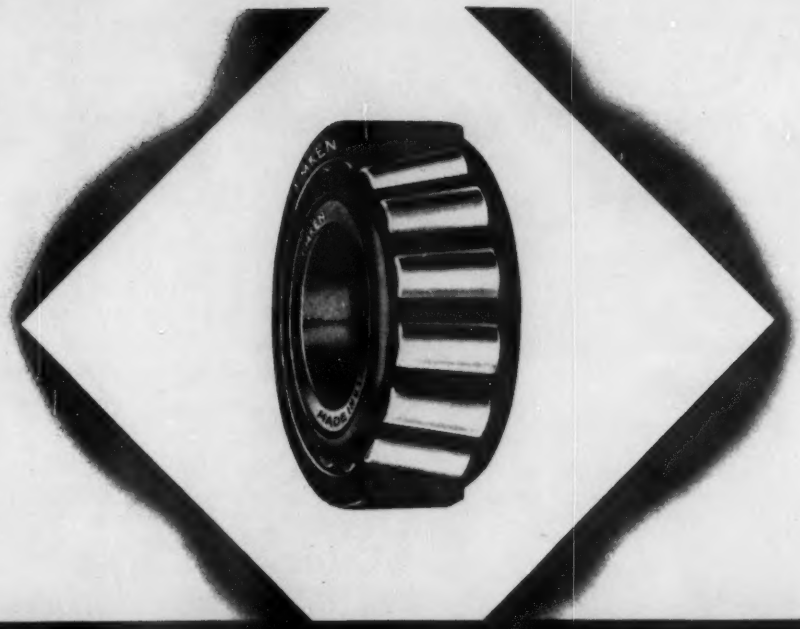
same German people have been thrown into such a state of despair that they show no anguish — no moral indignation — at the treatment the outcasts receive.

If we Americans are to see the ruthless, fascist way of life exterminated from the earth, we must try to enlighten those among us who lack moral indignation for the immoral activities of the fascist states. If we undergraduates at Tech are to lead the lives we desire and are now preparing for, we must ignore the despairing utterances of those who argue "peace at any price," "let the British fight their own wars," and "don't risk the chance of going to war." We must give the British every help we can. They do not need our men but they do need the implements of war we can manufacture for and send them, even if we have to risk going to war ourselves. Mr. Churchill said in his radio address on February 9: "Give us the tools and we will finish the job."

Hitler and his stooges attack a country long before they fire any guns or bomb the victims' cities. They have already attacked and invaded the United States. Hitler's agents are at this very moment doing their utmost to smash the moral indignation of the people of this country. Can he succeed? Not if we open our eyes and show our friends across the water more than pity; not if we awake from the moral stupor Hitler's agents would lull us into.

Democracy is slow and ponderous at times, but does any American prefer a dictator who shoots whomever he hates or fears? Those who say we should make peace now evidently have lost faith in democracy. If they do not wish to fight for a heritage we have kept for one hundred years, let them keep quiet. Let the judgment of true-blooded Americans who have the power and will to become actively and morally indignant at the crimes committed by the fascist rulers determine our government's policy. The path of the appeasers is dangerous, for the words of the fascist rulers have proven false.

Cy La Tour and Son



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G-E Campus News

SPEED INDICATOR

WHEN an airplane catapult hurls a plane into the air too fast, the pilot may be injured and unnecessary strain put on the plane. If the plane takes off too slowly, it will drop into the water. In the past, barrels have been substituted for planes for testing purposes.

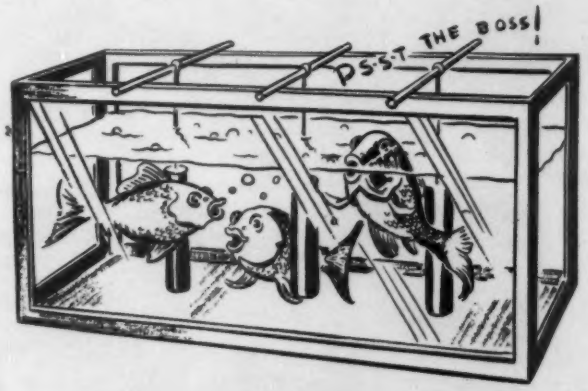
A new speed indicator, designed by the General Electric Company, checks the adjustment of the catapult without risking pilot or plane. The skid is shot down the track empty; if it registers the proper speed, the plane can then be placed on it and launched into the air at the correct speed. With some changes the equipment may be used to time other moving objects.

EYES FOR DEFENSE

PEOPLE in and around Schenectady, N. Y. are looking up these nights, watching the beams from giant searchlights being tested at the General Electric plant. In other parts of the world whole cities huddle underground, while sirens wail and bombs crash—but these Americans watch without fear. The sharp fingers of light sweeping silently across the sky are reassurance, symbols of security. Industry is on the job, providing the eyes of defense.

Searchlights are not the only defense items being built in Schenectady and in the other plants of General Electric. Great steam turbines are under construction, totalling millions of horsepower, to drive the ships of America's expanding navy; intricate controls will direct the operation of warships, tanks, planes, and guns; radio equipment will facilitate communication on land and sea and in the air.

And playing a vital part in these defense preparations are Testmen, young student engineers just off the campus, whose responsibility it is to test these machines.



INDUSTRIOUS FISH

SAMUEL JOHNSON, a chemist in the General Electric plastics research laboratory at Pittsfield, Mass., has three fish as helpers.

A large glass jar, used in the laboratory to keep a constant temperature bath for measuring the viscosity of plastic materials, collected scum inside, making the glass opaque. Since it was necessary to look through the glass, the jar had to be emptied and scoured once or twice a week. This was a tedious job, because the scum stuck. Acids didn't work. Snails were even put in the jar as scavengers, but high temperatures killed them. Then, just by chance, Johnson tried three goldfish from the "five and ten."

The fish took to the scum like a kitten takes to milk; within two or three days the jar was as clean as a whistle. It has remained so ever since.

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